**Testing Le Chatelier’s Principle:** Pre-Lab Questions

Name Teacher’s Solutions

1. Assume that the following reaction is in chemical equilibrium:

N2(g) + 3H2(g)eqarrow 2NH3(g) + heat

Explain the effect of each of the following changes upon the system in terms of Le Chatelier’s Principle and a shift towards either the products or the reactant side.

1. More hydrogen is added to the system – shift to the product side
2. Ammonia is removed from the system – shift to the product side
3. Nitrogen is removed from the system – shift to the reactant side
4. The temperature is raised – shift to the reactant side
5. The pressure of the system is decreased by doubling the total volume – shift to the reactant side

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| 2. Which describes a solution that contains a system at equilibrium? One in which the color of the solution is changing slowly, or one in which the color is not changing. Explain your answer.  A solution that contains a system at equilibrium is one in which the colour of the solution is not changing. At equilibrium reactant and product concentrations stop changing because the forward and reverse rates have become equal. That state is reflected in a fixed colour of solution, indicating no net change in the system. |
| 3. The following equilibrium is established when copper ions and bromide ions are placed in solution.  heat + Cu(H2O)62+ + 4 Br- eqarrow 6 H2O + CuBr42-  The tube on the left contains only copper sulfate dissolved in solution. The tube on the right is the result of adding some potassium bromide solution. Given that the Cu(H2O)6+2 ion is blue and that the CuBr4-2 ion is green, answer the questions below.  cubr   1. What happened to the concentration of each of the ions when the KBr was added?   Concentration of Br- and CuBr42+ increased  Concentration of Cu(H2O)62+ decreased   1. Explain why the solution changed color.   The equilibrium position shifted to the right when Br- ions were added on the left. The net change was a decrease in blue Cu(H2O)62+  ions and an increase in the green CuBr42+ ions. This is visually expressed as a change in colour from blue towards green.   1. Would the tube feel hot or cold when the KBr was added? Cold (more heat is consumed as the reaction shifts to product side) |
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**Testing Le Chatelier’s Principle:** Post-Lab Questions

Name Teacher’s Solutions

1. Rewrite both chemical equations. Under each reactant or product write its characteristics such as colour.

Reaction #1

Co(H2O)62+(aq) + 4Cl-(aq)eqarrow CoCl42-(aq) + H2O(l)

blue

Pink

Reaction #2

Fe3+(aq) + SCN-(aq)eqarrow FeSCN2+(aq)

clear

clear

Red/Orange

1. In the first reaction, which direction did the equilibrium shift? What was the visual indication of this shift?

When the HCl was added to the test tube, the reaction shifted to the right, towards the products side, turning the solution blue. When the water was added to the test tube, the reaction shifted left, towards the reactant side, turning the solution pink.

1. In the second reaction, which direction did the equilibrium shift? What was the visual indication of this shift?

When FeCl3 is added to the stock solution it increases the concentration of Fe3+ ions, the reaction shifted to the right, towards the product side, turning the solution a darker red/orange colour. When KSCN is added to the stock solution it increases the concentration of SCN- ions, the reaction shifted to the right, towards the product side, turning the solution a darker red/orange colour. When AgNO3 is added to the stock solution it decreases the concentration of Fe3+ ions, the reaction shifted to the left, towards the reactant side, turning the solution clear. When KSCN was added to this solution (stock solution and AgNO3) it increases the concentration of SCN- ions, the reaction shifts to the right, towards the products side, turning the solution a darker red/orange colour. When FeCl3 was added to this solution (stock solution and AgNO3) it increases the concentration of Fe3+ ions, the reaction shifts to the right, towards the products side, turning the solution a darker red/orange colour.

1. Use Le Chatelier’s principle to explain the colour changes in each experiment.

When HCl is added in the first reaction, it stresses the reaction by increasing the concentration of Cl- ions. To alleviate this stress the reaction shifts towards the product side to decrease the concentration on Cl- ions and increasing the concentration of CoCl42- which causes the solution to take on a blue colour.

When either FeCl3 or KSCN is added in the second reaction, it stresses the reaction by increasing the concentration of Fe3+ or SCN- respectively. To alleviate this stress the reaction shifts towards the product side to decrease the concentration of the Fe3+ or SCN- respectively and increasing the concentration of FeSCN2+ which causes the solution to take on a dark red/orange colour. When AgNO3 is added, it stresses the reaction by decreasing the concentration of Fe3+ ions. To alleviate this stress the reaction shifts towards the reactant side to increase the concentration on Fe3+ ions which causes the solution to turn clear.

1. The barium ion is toxic to humans. However, barium sulfate is commonly used as an image enhancer for gastrointestinal x-rays. What does this imply about the position of the equilibrium shown below.

BaSO4 eqarrowBa2+ + SO42-

This implies that the equilibrium is shifted to the left, towards the reactant side.

1. Hemoglobin (Hb) and oxygen gas form a complex (HbO2) that carries oxygen throughout the human body. Unfortunately, carbon monoxide also binds to hemoglobin so that equilibrium is established. Carbon monoxide poisoning occurs when the concentration of HbO2 in the blood is reduced.

HbO2 + CO eqarrowHbCO + O2

The first aid for a person suffering from carbon monoxide poisoning is to (1) remove them to an area of fresh air, and (2) administer oxygen. Using the principles of equilibrium, explain how each of these helps to restore the HbO2 concentration.

1. Removing them to an area of fresh air reduces the amount of CO in their system therefore shifting the reaction to the product side increasing the amount of oxygen bound to hemoglobin.
2. Administrating oxygen increases the amount of oxygen in their system therefore shifting the reaction to the product side increasing the amount of oxygen bound to hemoglobin.
3. Methanol has the formula CH3OH and can be produced by the reaction of carbon monoxide with hydrogen gas.

CO + 2 H2 eqarrow CH3OH + heat

In an attempt to maximize the yield of methanol (amount of methanol produced), a chemist would try to shift the equilibrium as far to the right as possible. Which of the following would accomplish this? Explain.

1. Heating the mixture (no)
2. Adding an excess of carbon monoxide (yes, shift to the product side)
3. Removing the methanol as it is formed (yes, shift to the product side)
4. Adding a substance that reacts with carbon monoxide (no)

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